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ORIGINAL ARTICLE

The main role of energy sustainability indicators on the water management

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Abstract
Without a doubt during human life, the role of water in our life is the most vital. Water is necessary for human survival and other kind of existing ecosystems. Due to the increasing population and climate change of the earth, human societies need freshwater sources and conservation more than ever before. According to these rapid changes in the importance of water sources, positive actions by the United Nations (UNs) are increasing around the world. Regarding the dramatic increase in energy demand, especially in the water industry, water management plays a significant role in this industry, especially for urban areas. Hence, water management can be useful as a practical and applicable method to achieve energy sustainability and prevent water waste. The main objective of this study is to investigate the four influential indexes, including policy, economy, environment, social and most important indicators that have an impact on water management based on energy sustainability. A new way to achieve energy sustainability using appropriate indicators for water management is crucial, thus correct selection and how to implement them is essential. The result of this study shows, if energy experts and policymakers have a proper strategy and appropriate actions, can improve the situation of water management for megacities and urban areas.

Keywords Water management · Index · Energy sustainability · Indicators

Introduction

Water resources are considered as natural sources that are vital to human life, boosting the economic growth of human societies and industrial activities. Water utilization has played a substantial role in numerous purposes, such as petrochemical industries, agricultural. Success in economic growth requires how to utilize the existing ecosystem to meet water and energy needs, as well as the performance of many production and consumption processes that interfere with these two factors as irreplaceable inputs. As most of the water sources are saltwater and there is only a few percent's of total water is freshwater, it should be taken into consideration to intelligently manage the freshwater and how to improve the administration of wastewater in subsections that have not had any problems with the quality of water such as industrial units. As can be seen in Fig. 1, only a small fraction of remained water is accessible, and most of it has been frozen (Gleeson et al. 2012; Davarpanah 2018; Davarpanah and Mirshekari 2020). Not only without water, life will not have importance, but also all industries and agricultural will be destroyed. There are some important factors that can affect our water source ecosystem such as, global warming, population growth, urbanization and increasing water consumption. It is expected, food production is increased near 70 percent in 2050, which may require up to 50 percent more water, while by 2050, and about 2.4 billion people will face absolute water shortages. Thus, conserving of water is so important (Westall and Brack 2018; Davarpanah and Mirshekari 2019a; Kakoli et al. 2016; Valizadeh et al. 2020). As we all know, water is one of the valuable sources

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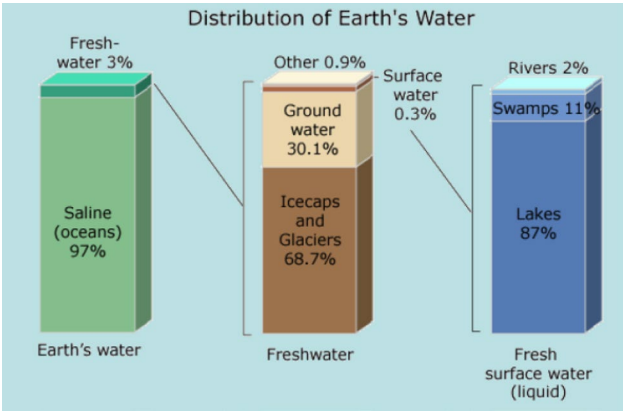

Fig. 1 Sketch of water distribution on Earth. By NASA Official website

that exist in nature and capable of producing a significant amount of energy. Water sources management is critical to the development of a country, as it is considered as one of the areas of employment and energy security of any country (Davarpanah et al. 2018; Nassabeh et al. 2019; Valizadeh and Davarpanah 2020).

Water management is one of the most critical issues in the whole world. Water is necessary for industrials, agricultural and other parts that human is involved with it. Because of it, water management is vital (Mulder and Kaijser 2014; Kasim et al. 2014; Molden 2013; Ebadati et al. 2019). On the other hand, energy supply is considered as a priority for all countries around the world. In this case, water sources have of high significance for achieving this target (Le and Nunes 2016; Prashar 2019; Davarpanah et al. 2019). Today, there are plenty of new technologies and policies to optimize water management and maximize its use in the energy cycle, and policymakers and planners are well aware of its importance (Davarpanah and Mirshekari 2019b). Although conserving of water sources is not possible for the long term, the use of proper approaches such as management can prevent the of loss it extremely (Mitiku et al. 2006). Moreover, long-term plans and proper management will be significant for the management of water sources and wastewater. Hence, attention to the conservation and management of water sources while preventing its loss has substantial effects on increasing productivity and creating a good energy base (Gleick et al. 2003). Described a useful sustainable water management index for managers in assessing the sustainability of water management and also assessing the impact of policies implemented to the water sustainability. The proposed index structure is achieved using the European legal framework in the water sector, and basic indicators such as environmental, economic, social and institutional nature (Maiolo and Pantusa 2019). Marttunen et al. (2019) explained a systematic approach to assess water security and its future trends through a collaborative process by the utilization of a hierarchy framework for water security. It has consisted of four main issues; water environment status, human health and well-being, sustainability, and the stability, functions and responsibilities of each society.

Energy sustainability is one of the most critical subjects in the world (Razmjoo et al. 2019c). To achieve sustainable management of water sources and to avoid waste of those, there are many applied strategies and different management practices (Juwana et al. 2012; Kluczek 2019). One of the essential strategies is the use of useful indicators. Utilizing of indicators in urban areas and everywhere is an affirmative action (Razmjoo et al. 2019c; Armin Razmjoo et al. 2020). Moreover, indicators have used to develop the urban areas as a reliable energy supply to optimize the waste water management efficiency (Chaves and Alipaz 2007). In this sense, the selection of appropriate indicators is one of the most effective and effective strategies for energy sustainability especially water sources (Balkema et al. 2002; Razmjoo 2019).

One of the most critical areas that needs too much energy is the urban areas. Due to the high population and electrical equipment of the megacities and urban areas, these areas always need more and more energy supply (Razmjoo 2019). Human societies to achieve energy sustainability need planning and proper strategies including multi-scale analysis. In this regard, policymakers and energy experts can have an influential impact to reduce related problems (Razmjoo et al. 2019a, c). It can be mentioned using these explanations that the water management sector, especially water recycling, moreover prevents waste of energy source and can have remarkable effects on the environment, especially for green urban areas. Many researchers have studied on energy sustainability related to water sources and water treatment that some of them can be mentioned. Mc Nabola et al. investigated using micro-hydropower the energy recovery in the water industry. Mc Nabola explained the energy recovery has investigated as a way to improve sustainability (McNabola et al. 2013). Lundin M et al. investigated the urban water systems development based on a life cycle assessment, and also useful indicators were considered to improve these systems in urban areas (Lundin and Morrison 2002). Choi and Sirakaya (2006) presented useful indicators for water management, and especially proper indicators were presented for the tourism activities and improve water systems industries. Balkema et al. investigated the indicators to assess the sustainability in wastewater treatment systems. They in this study investigated technical, economic, social and environmental issues in the line of water sustainability (Balkema et al. 2002). Makropoulos et al. presented a decision support tool for sustainable option selection to integrated water management in urban areas. The tool was able to investigate the interactions between the major urban water cycle streams concerning water balance model. In this

model, the GA algorithm was used to technology selection of the decision space (Makropoulos et al. 2008). Van de Meene et al. (2011) presented a conceptual study for sustainable urban water management using different interviews data, regime attributes for sustainable urban water governance, and a governance approach was proposed. The novelties are in this study, focused on the improvement of water management in urban areas to achieve energy sustainability. Firstly, investigates energy sustainability based on three important sections of sustainable development plus policy section. Secondly, presents remarkable indicators that have the most effect on water management for achieving energy sustainability. As above mentioned, the main objective for bringing these novelties is moving toward having development in water management in urban areas, therefore is necessary that studied accurately indicators by policymakers, energy experts investigate and implemented. In this regard, if these indicators and related parameters are implemented, without a doubt effective impact will be created in water management systems in urban areas and much problems will be removed for their inhabitants.

Nowadays, the importance of energy supply for all countries is considered as a priority and energy sustainability is more important to them. Water is one of the valuable sources that exist in nature and capable of producing a significant amount of energy. Water sources management is essential to the notional development, and as it is considered as one of the areas of employment and energy security of all countries (Loucks et al. 2005). Today, there are plenty of programs and policies to optimize water management from the economic view and energy cycle, policymakers and planners are well aware of its importance (Pulido-Velázquez et al. 2006). Therefore, the renewable energy sustainability indexes were defined as a composite list to provide more details in water management issues. That could be a suggested indicator in the national monitoring mechanism that shows the strengths and weaknesses of a national government in terms of renewable energy and also tested the proposed indices in 15 European Countries (ECs) that were ranked by the final energy consumption with different levels of development (Cîrstea et al. 2018). The conservation of energy sources, especially water, is not possible for the long term, but appropriate approaches can prevent the extra consumption and loss it. Hence, long-term plans and proper management of the management of water sources and wastewater will be critical (Jønch-Clausen 2004). Attention to the conservation and management of water sources to preventing its loss has significant effects on increasing productivity and creating a good energy supply base (Wang et al. 2001). Achievement to water sustainability needs assigning appropriate strategies and applicable indicators to prevent loss water and maximum use it (Hellström et al. 2000). Use of relevant indicators can be sufficient to improve water systems and make water sustainability for a society. But selecting indicators should be measured and accurately investigated before implementation (Seager 2001).

Due to the limited water sources, the optimal utilization of these sources for supplying drinking water and other services is the most influential (Vigneswaran and Sundaravadivel 2004). Also, the use of water harvested in the event of health confirmation will have a positive impact on the conservation of water sources. Water recycling is an effective method to optimize the use of water sources and prevent loss (Asano 2002). Recycling can be one way to get out of the water crisis in the industry (Klemeš 2012). Thus, one of the new energy policies in each community is the proper management of water resources and the reuse of waters (Hanjra et al. 2012).

One of the most crucial questions is, what are indicators, and what is the benefits them?

Indicators are used as quantified information and can help to explain how some things are essential and use of them is sufficient. Indicators are used in various sections to achieve sustainable standards (Hák et al. 2012). For urban areas, indicators have a remarkable role in decision making and use by policymakers and urban planners. The duty of indicators is simplification of the complexed issues with enhancing knowledge of people (Tanguay et al. 2010). Also, indicators have a positive impact on energy sustainability thus selecting reasonable indicators to lead to essential positive changes in the economy, environment and social which are the critical sections of sustainable development (Zolfani and Saparauskas 2013). In this study presented, the most critical indicators have a remarkable impact on energy sustainability for water management systems. In this regard, indicators such as planning, affordable, water health, management, equality and technology for all inhabitants of urban areas should be considered and implemented by energy experts and policymaker to achieve energy sustainability. Proper investigation and implementation of each indicator can lead to improvement of water management in urban areas for their inhabitants.

Concerning the importance of assessing the sustainable management of water sources in terms of energy and environmental requirements and prevention of wastewater, attention to energy sustainability is significant for each country. In this study, four main indexes related to water management sustainability for urban areas investigated conceptually and then for each of them assigned relevant indicators. Indeed, each index were described separately based on relation to water management. This study is divided into two main sections. The first section explains conceptually about four main influential indexes in water management, and the second section presented related indicators for these indexes. As before mentioned, the main aim of this study is to investigate the useful indicators that are proper to implant in urban areas

to prevent waste of water and achieve energy sustainability. Part 4 explains the most important indexes related to water management and energy sustainability.

Effective energy sustainability indexes in water management

Policy sector

The importance of energy for our world is proved for everyone (Armin Razmjoo et al. 2020; Razmjoo et al. 2019b). In this regard, water as a valuable material is clear for everyone. Also, water has a strategic and remarkable position in public policy of each country. Considering the growing population, the development of economic activities and the rise of living standards which have led to a significant increase in demand for water, today it is considered for strategic purposes and different policies to manage them (Mollinga et al. 2007). Today's legislators, by considering the new laws and policies in this sense, have sought better utilization of water sources for energy supply, but there are many concerns about the status of water sources and serious challenges (Molle et al. 2008). Since the importance of water management is like development management, thus the role of governments is remarkable to develop targeted management with due regard to the rules and programs. Considering the increasing population growth, the development of economic activities and the rise of living standards that have led to a significant increase in water demand, today, specific strategic purposes and policies are considered for energy sustainability by use of water management (Pahl-Wostl et al. 2008). The goal of water policy in recent years has been to manage water sources further and to assess better the effectiveness of water sources in the field of energy supply (Gregory et al. 2011). Over the past years, many efforts have been made to develop and implement appropriate indicators for use in water, energy and wastewater fields to gain sustainability for each society (Pereira et al. 2012).

Economy sector

Today, considering the environmental and economic conditions of any country, the importance of water and its optimal management is among the main goals. Also, since water management plays a significant role in sustainable economics and development, maintaining and optimizing its use is very significant and crucial (Mirumachi and Allan 2007). Energy economic systems are complex and have a close relationship with water management. Correct economic analysis has much to offer those who seek to understand energy issues and evaluate appropriate policy strategies. In this regard, it is not easy and it needs a vast appropriate insight (Kneese and Bower 2013). Hence, water management systems to energy supply can be investigated from the economic view.

Environment sector

Population growth, economic development, and rising living standards have dramatically increased demand for water. Hence, it has caused to the environment harvesting (Vörösmarty et al. 2000). As before mentioned, water is known as an essential source for our life on the planet that is a part of natural sources and the environment. Water comes from the heart of environmental, hence is belong it (Oki and Kanae 2006). At present, individual plans and much effort in water source management are done to optimizing the use of water and in minimizing the environmental impact of water use on the natural environment. Water source management and integration are a fundamental and essential method to conserve environment sources (Biswas 2004).

Social sector

Regarding it that access to water is social justice; hence, water management is essential for each social (Tisdell 2003; Vannevel and Goethals 2020). Also, water management is essential because all societies need water to continue life, energy supply, health, affect social services and industry (McLean 2007). Water management system and urban water supply have increased over the recent years in different countries particular for urban areas, but in this regard, some obstacles to implementing reforms remain (Loucks et al. 2005). Urban areas, because it has much population more, need to water consumption, thus making regulations for them in the water field is extremely necessary. Also, water management needs a better understanding of the effects of social changes, communities should become more involved in water management issues (Organization et al., 2015). Water source needs to regular planning and policy to prevent loss. Use of water sources is to serve people and reduce their issues. Thus, it requires regular planning and management (Stead 2014). Figure 2 shows the selected methodology for this study. As it is evident, to achieve energy sustainability, need to a regular program to water management and appropriate indicators. As can be seen, water sources for urban areas are vital, and conservation of it is necessary for national governments and energy experts because these sources have a key role in environment and energy supply. Four main indexes are presented in Fig. 2 that can have the most impact in urban areas. In the urban areas, correct policy, water available, water affordable and clean water are most important for inhabitants. Because of these causes, the role of management in each part should be investigated and improved accurately. One of the most

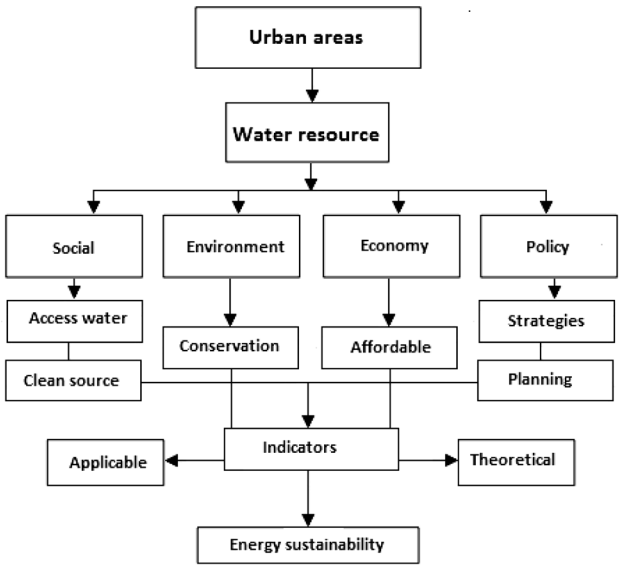

Fig. 2 Energy sustainability by water management indexes and indicators

important acts for this defines the useful indicators. These indicators have to help water management systems in the line of sustainability for inhabitants of urban areas. All of these indexes need to be related indicators. If policymakers and energy experts can implant these indicators correctly, achieve energy sustainability regarding water management will be feasible and achievable.

Results and discussion

Regarding the importance of water, water management is essential. Water management is an art that engineers can create by design (Groenfeldt 2019). Nowadays, due to rapid population growth and urbanization, water management has been done a severe issue. Water sources are essential for urban inhabitants from the different aspects of quality of life, especially to energy supply. In urban perspectives, water management has a critically important role in urban growth and achieves sustainability. Indeed, these plans increase the access water percent for inhabitants and welfare them. Without a doubt, many urban problems can be eliminated in the water field with proper and regular planning, and it leads to enhance the quality of life for inhabitants. Figure 3 shows the water management. Figure 3 shows a given plan from the first step that is the river to the final step that is products and also shows that water management has essential to prevent waste of water.

Water sustainability is as a remarkable issue for urban planners and policymakers. Therefore, achieving urban water sustainability is required to investigate and use of related indicators and implement them. The implementation of these indicators and strategies helps to optimize energy consumption and improve water use in urban areas. Also, correct selection and use of proper indicators are a confident tool to achieve urban water sustainability.

Water management indicators

Table 1 shows four main indexes with essential indicators based on Fig. 3. This table shows that consisted of four main indexes and indicators relevant energy sustainability will allow us concerning them, the identification of the best framework in sustainability to be more accessible. On the other hand, the appropriate strategies have been chosen to improve the quality of life of urban inhabitants from positive aspects and more applicable.

Water management importance

Since water management can be an appropriate method to better use of water sources, and it has a remarkable impact on energy sustainability, a summary of previous studies is put in Table 2. As can see, these researches have been done with an emphasis on sustainability in water and having a plan for water management. The most important common points of the present study with these works are planning, strategies and investment for developing and implementing

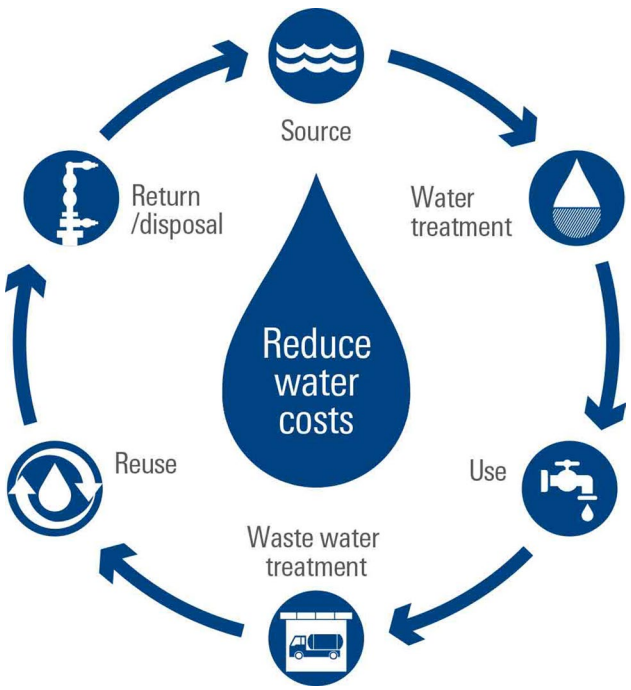

Fig. 3 Water management process

Table 1 Four main indexes with related indicators for water management

Index	Important indicators based on four main indexes	Indicator improvement methods
Policy	Measurable, applicable	Strategy, planning, management, investment
Economy	Affordable, economic benefit per capita	Proper consumption, technology
Environment	Renewable	Conservation, correct use, recycle
Social	Equality, healthy, reliable, availability, sustainable, high freshwater quality	Planning, new technology, management, water supply, drinking water systems, recycle

Table 2 Water management importance

Research subject	Main authors	Result
A critical review on sustainability assessment of recycled water schemes	Chen et al. (2012)	Investigation environmental assessment tools such as LCA (Life cycle assessment), MFA (Material Flow Analysis) and ERA(Environmental Risk Assessment) moreover study several management strategies
Indicators for the sustainability assessment of wastewater treatment systems	Balkema (2002)	Assignment boundaries and sustainability indicators, quality of indicators and appropriate strategies
Energy and water sustainability	Golden et al. (2006)	Assigning climatic impacts as a function of land-use change from urbanization by modeling and data. Consideration of electrical and water consumption amount
Sustainability in Water-Energy	Ozturk (2015)	Emphasis on proper policy, investment and research in sustainability
Water Use Model for Quantifying Environmental and Economic Sustainability Indicators	Sahely and Kennedy (2007)	Presenting a useful model of the urban water cycle for analyzing the flows of water, energy and to demand management
Water, Environment, Energy, and Population Growth	Singh et al. (2014)	We are emphasizing on integrated energy management with doing some works for achieving fundamental changes such as data gathering and processing, hypothesis formulation and modeling and public participation
City Blueprints: 24 Indicators to Assess the Sustainability of the Urban Water Cycle	van Leeuwen et al. (2012)	Investigating the appropriate essential indicators urban areas such as water security, water quality, sanitation, infrastructure, climate robustness to integrate urban water management and reduction in the main problems for these areas

sustainability for water management and better use this valuable source of energy.

Conclusion

Water sources are an essential part of the environment, nature and are potentially useful to energy supply. Conservation of water sources, especially water reuse, is essential for each country. Also, sufficient attention to water sources and management it has a positive impact on our future. The main objective of the present study was a careful consideration of water management for urban areas with an emphasis on energy sustainability based on economic, social, environment and policy indexes. As the urban areas are crowded in each country and need to more water consumption, thus, attention to water management should be investigated as a vital subject for inhabitants. But water management is not only enough and utilizing proper indicators should be considered by energy experts and all responsibilities of urban areas and implanted accurately. One of the essential actions is appropriate approaches and strategies in all sections. This study showed that having proper strategies that can be applied by policymakers and energy experts for water management can be a lead better use of water sources that this action will have positive impacts on economic, social and especially the environment sections of urban areas. Hence, present and implement appropriate indicators related to water management and in the line of energy sustainability should be considered accurately to achieve water sustainability plan.

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